

Ministry of Education

Identified Competency Focus Areas and Core Courses for

Ethiopian Higher Education Institutions’ Exit Examination

Program: - BSc in Electrical Engineering

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# Introduction

Electrical and Computer Engineers (ECE) design and implement devices, circuits and systems for electronic communication, computing, electrical power, control and related applications. Graduates of the Electrical and Computer Engineering program play key role in the development of the country.

The ECE curriculum focuses on broad-based training to provide flexibility of career choices and focused training to provide competence in particular electrical engineering profession. It finds balance between breadth and depth to provide a solid foundation in the basic engineering, mathematics, electrical engineering on one hand, and comprehensive training in humanities and management on the other.

* The freshman courses are developed nationally by MoE.
* In the third semester students will join the pre­engineering program.
* In the four consecutive semesters, after pre­engineering, all the students take courses mainly in the core electrical engineering module.
* In the final three semesters, students are given the opportunity to focus on one of the five areas, namely communication engineering, electrical power engineering, computer engineering, industrial control engineering and microelectronics engineering.

In Ethiopia Higher Education Institutions (HEIs), in general, and the engineering education in particular, have embarked on major reform since the last decade. Notable in this regard is the capability building in the Engineering Capacity Building Program (ECBP) program, which was initiated in 2006.

Since 2012 E.C, the Ministry of Education (MoE) through one of its wings, Higher Education Strategic Center (HESC), has initiated to have modularized curricula in all programs in HEIs and to harmonize a program among institutes offering the same program.

As of 2014 E.C the Ministry of Education has planned to implement university exit exam to start from 2015 E.C. As part of this effort, this document was prepared during the workshop prepared by MoE between July 18 – 19, 2022 in Bishoftu, Ethiopia. This document outlines competencies and courses that can evaluate the student in key skills and knowledge upon completion of the program.

To come up with the electrical and computer engineering competency and course list for university exit examination, key graduate profiles of electrical and computer engineers were first selected from relevant curriculum. Based on the identified graduate profiles, competency and learning outcomes were identified. After this, courses were selected that can evaluate the identified competency and learning outcomes. And finally, the courses were categorized into themes.

# Expected profiles of graduates

Electrical and Computer Engineering is the branch of engineering that deals with the technology of electricity and electronics, especially the design and application of electronic circuit, equipment for power generation and distribution, machine control, communications and computer hardware and software. Graduates of this program are required to have the necessary competency to undertake these activities. The knowledge and skills expected are divided into basic skills, engineering knowledge and skills and specialization specific knowledge.

## Basic Skills

These represent the basic skills required for any graduate to work in a professional environment. Some of these skills are the following.

* Able to understand the state of art techniques, devices, software, protocols.
* Proceeding in methodical approach to solve problems.
* Working independently, assuming responsibility.
* Communicate effectively, in both written and orally, on complex electrical and computer engineering activities with a variety of audiences.
* Being a team member communicative, cooperative and transparent.
* Managing projects, productions, manpower and resources cost effectively.
* Recognize the personal, national and global needs for in the broadest context of technological dynamism.

## Engineering Knowledge and Skill

These represent the engineering knowledge and skills required for any electrical and computer engineering graduate. Some of these skills are the following.

* Fundamental knowledge in engineering mathematics.
* Fundamental knowledge in physics, EM fields, semiconductors.
* Knowledge in electrical machines, electronic analogue and digital circuits, signal & system, measurements, control, microprocessor and communication.
* Design solutions for complex engineering problems and systems considering for public, health, safety, cultural, societal and environmental considerations.
* Conduct experiments, analyze and interpret results.
* Create, select and apply appropriate techniques, resources and modern engineering and ICT tools to complex electrical and computer engineering problems.
* Knowledge in computer hardware and software.

## Profiles for Streams (Focus Areas)

The following streams (focus areas) of Electrical and Computer Engineering are identified as very important for development of the country. A student selects one of these streams at later stage of his/her study and specializes in the area.

### Communication Engineer

* Analyze, design and implement modern communication equipment and systems.
* Manage and upgrade communication/telecommunication industries.

### Electrical Power Engineer

* Analyze and design electric power systems.
* Participate in the assessment and development of renewable energy technologies for the national grid expansion as well as rural electrification efforts.
* Analyze and design protection systems for electrical and mechanical systems.

### Industrial Control Engineer

* Analyze, design and implement industrial control equipment and instrumentation.
* Analyze and design microprocessor based control systems and algorithms.

### Computer Engineer

* Analyze, design and implement computer hardware and software systems and applications.
* Integrating and administering hardware and software systems.

### Electronics Engineer

* Analyze, design, develop, produce and test electronic systems.

# Competencies and learning outcomes

The competencies and learning outcomes envisaged to be evaluated by the university exit exam of electrical and computer engineering are categorized into core electrical engineering and specialization specific competencies.

## Core Electrical Engineering Competency

This competency is the heart of the program, which provides foundation for the electrical and computer engineering. The core learning outcomes are the following.

* Analyze
  + Fundamental concepts of signals, systems and electrical and electronic engineering.
  + Computer architecture and programming.
* Design
  + Communication, control and power systems using basic concepts of electrical and computer engineering.
  + Computer architecture and programming
* Practical skills
  + In installation and maintenance of electrical and computer systems.

## Specialization specific competency

This competency is specific to the five specializations of the electrical and computer engineering disciplines. A prospective graduate is expected to have competency of one of the following specializations.

### Communication Engineering Competency

* To analyze, design and implement modern communication equipment and systems.

### Electrical Power Engineering Competency

* To analyze, design and implement electric power systems.

### Computer Engineering Competency

* To analyze, design and implement computer hardware and software systems and applications.

### Industrial Control Engineering Competency

* To analyze, design and implement modern industrial control system, equipment and instrumentation.

### Microelectronics Engineering Competency

* Analyze, design, develop, produce and test electronic systems for various applications.

# Courses to be included in the exam

Electrical and Computer Engineering students take 60 – 65 courses and it is unrealistic to try and evaluate the student their competency of all these courses by just one university exit examination. Therefore, only 17 courses are selected that can evaluate the competency of the student in key skills and knowledge that are identified in the competency and learning outcome section. It should also be noted that the questions from the selected courses should focus on long term knowledge and transferrable skills by taking into account the open book theme of professional practice. These courses are selected from core courses that are common to all and specialization courses for each stream.

## Core courses common to all specializations

The following courses were selected to evaluate the core electrical and computer engineering competency.

* ECEG­2121 Fundamental of Electrical Engineering (Circuit)
* ECEG­3162 Object Oriented Programming
* ECEG­2131 Applied Electronics I
* ECEG­2141 Signals and System Analysis
* ECEG­3151 Introduction to Electrical Machines
* ECEG­3153 Electrical Workshop Practice II
* ECEG­3163 Computer architecture and Organization
* ECEG­3171 Digital Signal Processing
* ECEG­3174 Introduction to Communication Systems
* ECEG­3175 Introduction to Control Engineering
* ECEG­3176 Introduction to Power Systems
* ECEG­3173 Introduction to Instrumentation

## Specialization specific courses

These courses are specific to each of the five specializations and a prospective graduate is expected to have competency in one of these five specializations.

### Computer engineering specialization

* ECEG­4181 Microcomputers and Interfacing
* ECEG­5212 Computer and Network Security
* ECEG­4211 Data Communication and Computer Networks
* ECEG­5193 Algorithms Analysis and Design
* ECEG­5222 Embedded Systems

### Electrical power engineering specialization

* ECEG­4242 Power Electronics
* ECEG­4261 Electrical Installation
* ECEG­4251 Power Systems
* ECEG­5262 Energy Conversion and Rural Electrification
* ECEG­5252 Power System Protection

### Electronic communication engineering specialization

* ECEG­4301 Communication systems
* ECEG­4311 Data Communication and Computer Networks
* ECEG­5312 Telecommunication Networks
* ECEG­5322 Antennas and Radio Wave Propagation
* ECEG­5313 Wireless and Mobile Communication

### Industrial control engineering specialization

* ECEG­4231 Modern Control Systems
* ECEG­4261 Electrical Installation
* ECEG­5344 Electrical Drives
* ECEG­5352 Digital Control Systems
* ECEG­5373 Industrial Process Control and Automation

### Electronics engineering specialization

* ECEG­4381 Principles of Electronic Design
* ECEG­4281 Microelectronic Devices and Circuits
* ECEG­4181 Microcomputers and Interfacing
* ECEG­4221 VLSI Design
* ECEG­5392 High Frequency Electronic Devices and Systems

# Categorizing courses into themes

The courses are categorized according to the expected competencies of a prospective graduate of Electrical and Computer Engineering.

## Analysis of fundamental electrical engineering concepts

* ECEG­2121 Fundamental of Electrical Engineering (Circuit)
* ECEG­2131 Applied Electronics I
* ECEG­2141 Signals and System Analysis

## Practical skill

* ECEG­3153 Electrical Workshop Practice II

## Analysis and design of computer architecture and programming

* ECEG­3162 Object Oriented Programming
* ECEG­3163 Computer architecture and Organization

## Analysis and design of basic electrical systems

* ECEG­3171 Digital Signal Processing
* ECEG­3151 Introduction to Electrical Machines
* ECEG­3174 Introduction to Communication Systems
* ECEG­3175 Introduction to Control Engineering
* ECEG­3176 Introduction to Power Systems
* ECEG­3173 Introduction to Instrumentation

## Design and implementation for Specializations

### Computer engineering specialization

* ECEG­4181 Microcomputers and Interfacing
* ECEG­5212 Computer and Network Security
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# Conclusion

In conclusion, based on identified graduate profiles, competencies and learning outcomes 17 courses were selected to evaluate the competency of Electrical and Computer Engineering graduates. This draft competencies and list of courses for university exit exam for electrical and computer engineering should be reviewed and discussed with all the other universities and stakeholders.

The list of courses may be updated based on curriculum revision if there is an addition or removal of courses from the identified set of courses.

For successful competency evaluation of the students the following key points should be taken into account.

* The examination questions should focus on key knowledge of each specific course instead of detailed assessment that has already been undertaken in their course work.
* The examination questions should focus on long-term knowledge and transferrable skill.
* It should also take into account the student ECTS load during graduation time.
* The timing and administration of the competency examination should not be a hindrance for timely graduation.